What is claimed is:

1. A communication control device functioning as a parent station device, which is connected with a plurality of child station devices through a single transmission medium and a multiplexing-demultiplexing unit, comprising:

a slot allocation information inserting unit for determining slot allocation information indicating the allocation of slots of an upward signal to each child station device and inserting the slot allocation information of the child station devices into a downward signal;

a slot allocation information storing unit for storing the slot allocation information determined in the slot allocation information inserting unit;

a packet checking unit for checking whether or not upward packets exists in slots of an upward signal and producing packet existence information;

a traffic estimating unit for detecting the existence of the upward packets in prescribed slots corresponding to the slot allocation information of each child station device stored in the slot allocation information storing unit according to the packet existence information produced by the packet checking unit and estimating a traffic volume of upward packets sent from the child station device in a future time according to the existence of the upward packets in the prescribed slots corresponding to the slot allocation information of the child station device; and

a slot allocation changing unit for changing the slot allocation information of the child station devices

determined by the slot allocation information inserting unit according to the estimation of the traffic volume obtained in the traffic estimating unit.

2. A communication control device according to claim 1, wherein slots of the upward signal received after the passage of a known delay time from the insertion of the slot allocation information performed by the slot allocation information inserting unit is detected by the packet checking unit as the prescribed slots corresponding to the slot allocation information to detect the existence of the upward packets in the prescribed slots.

3. A communication control device according to claim 1, wherein the traffic volume of upward packets sent from each child station device in the future time is estimated by the packet checking unit according to the existence of the upward packets in the prescribed slots corresponding to the slot allocation information of the child station device and a traffic estimated result obtained in a past time.

4. A communication control device according to claim 1, wherein a periodic change of the traffic volume is estimated by the packet checking unit according to the existence of the upward packets in the prescribed slots corresponding to the slot allocation information of the child station device and a traffic estimated result obtained in a past time.

5. A communication control device according to claim 1,

wherein slots corresponding to a minimum transmission bandwidth of each child station device is allocated to the child station device by the slot allocation changing unit, and a surplus transmission bandwidth is given to one child station device or is shared among the child station devices by the slot allocation changing unit according to the estimation of the traffic volume obtained in the traffic estimating unit.

6. A communication control device according to claim 5, wherein slots corresponding to a minimum transmission bandwidth of each child station device is allocated to the child station device in an initial allocation by the slot allocation changing unit.

7. A communication control device according to claim 5, wherein slots corresponding to a minimum transmission bandwidth of each child station device is allocated to the child station device in an initial allocation by the slot allocation changing unit, and a surplus transmission bandwidth is initially given to one child station device or is initially shared among the child station devices by the slot allocation changing unit at a prescribed proportion according to the estimation of the traffic volume obtained in the traffic estimating unit.

8. A communication control device according to claim 5, wherein specific slots of the upward signal are successively allocated to one child station device by the slot allocation changing unit until the estimation of the

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traffic volume in the child station device is obtained in the traffic estimating unit.

9. A communication system, comprising:

a communication control device functioning as a parent station device; and

a plurality of child station devices, which are connected with the communication control device through a single transmission medium and a multiplexing-demultiplexing unit, for respectively inserting upward packets in particular slots of an upward signal according to slot allocation information which indicates the allocation of the slots of the upward signal to the child station device and is inserted into a downward signal sent from the communication control device, wherein

the communication control device comprises:

a slot allocation information inserting unit for determining the slot allocation information of each child station device and inserting the slot allocation information of the child station devices into the downward signal;

a slot allocation information storing unit for storing the slot allocation information determined in the slot allocation information inserting unit;

a packet checking unit for checking whether or not the upward packets exists in slots of the upward signal and producing packet existence information;

a traffic estimating unit for detecting the existence of the upward packets in prescribed slots corresponding to the slot allocation information of each child station

device stored in the slot allocation information storing unit according to the packet existence information produced by the packet checking unit and estimating a traffic volume of upward packets sent from the child station device in a future time according to the existence of the upward packets in the prescribed slots corresponding to the slot allocation information of the child station device; and

a slot allocation changing unit for changing the slot allocation information of the child station devices determined by the slot allocation information inserting unit according to the estimation of the traffic volume obtained in the traffic estimating unit.

10. A slot allocating method, in which slots of an upward signal is allocated among a plurality of child station devices by a communication control device functioning as a parent station device in a communication system in which the communication control device is connected with the child station devices through a single transmission medium and a multiplexing-demultiplexing unit, comprising the steps of:

determining the allocation of the slots among the child station devices;

inserting slot allocation information, which indicates the allocation of the slots of the upward signal to each child station device, into a downward signal;

storing the slot allocation information of the child station devices;

estimating a traffic volume of upward packets sent from

each child station device in a future time according to the existence of the upward packets in prescribed slots corresponding to the slot allocation information of the child station device; and

changing the slot allocation information of the child station devices according to the estimation of the traffic volume in the child station devices.

11. A communication control device, which is connected with a plurality of child station devices through a single transmission medium and a multiplexing-demultiplexing unit to communicate with the child station devices, comprising:

an upward packet output permission instruction producing unit for producing an upward packet output permission instruction indicating the allocation of the usable slots of an upward signal for each child station device;

an identification information producing unit for producing identification information from both a transmission delay time between the communication control device and one child station device and the upward packet output permission instruction of the child station device produced by the upward packet output permission instruction producing unit for each child station device;

an upward packet output permission instruction sending unit for sending each upward packet output permission instruction produced by the upward packet output permission instruction producing unit to the corresponding child station device to allow each child station device output upward packets arranged in the usable

slots;

a packet type judging unit for judging whether each of a plurality of upward packets sent from the child station devices in response to the upward packet output permission instructions produced by the upward packet output permission instruction producing unit is an upward information packet having valid information or an empty packet having invalid information;

an upward traffic measuring unit for identifying each child station device, from which a plurality of upward information packets and empty packets currently judged by the packet type judging unit are output, according to the identification information of the child station device produced by the identification information producing unit and measuring a traffic volume of the upward information packets output from each identified child station device according to packet type information obtained by the packet type judging unit;

an upward traffic estimating unit for estimating a traffic characteristic of the upward information packets output from each child station device according to the upward packet output permission instruction produced by the upward packet output permission instruction producing unit and the traffic volume measured by the upward traffic measuring unit; and

an upward bandwidth allocation determining unit for determining an upward transmission bandwidth allocated to each child station device according to the traffic characteristic estimated by the upward traffic estimating unit and changing the upward packet output permission

instruction produced by the upward packet output permission instruction producing unit according to the upward transmission bandwidth for each child station device to make the identification information producing unit change the identification information according to the changed upward packet output permission instruction for each child station device and to make the upward packet output permission instruction sending unit send each changed upward packet output permission instruction to the corresponding child station device.

12. A communication control device according to claim 11, wherein a plurality of slots of the upward signal of the upward packets output from the child station devices are partitioned into a plurality of upward transmission bandwidth control frames by the upward bandwidth allocation determining unit so as to control the outputting of the upward packets from each child station device in response to the corresponding upward packet output permission instruction changed by the upward bandwidth allocation determining unit in each upward transmission bandwidth control frame, and the corresponding upward packet output permission instruction instructs the corresponding child station device to output a plurality of upward packets at equal intervals in each upward transmission bandwidth control frame.

13. A communication control device according to claim 11, wherein a plurality of slots of the upward signal of the upward packets output from the child station devices are

partitioned into a plurality of upward transmission bandwidth control frames by the upward bandwidth allocation determining unit so as to control the outputting of the upward packets from each child station device in response to the corresponding upward packet output permission instruction changed by the upward bandwidth allocation determining unit in each upward transmission bandwidth control frame, and the corresponding upward packet output permission instruction instructs the corresponding child station device to output a plurality of upward packets at unequal intervals in each upward transmission bandwidth control frame.

14. A communication control device according to claim 11, wherein the traffic volume of the upward information packets output from each identified child station device is measured by the upward traffic measuring unit by measuring an upward information packet interval of each pair of upward information packets output from the identified child station device and the number of empty packets which are output from the identified child station device and are arranged between the pair of upward information packets, and the traffic characteristic is estimated by the upward traffic estimating unit according to the upward packet output permission instruction, information of the upward information packet intervals of the upward information packets and information of the number of empty packets.

15. A communication control device according to claim 12,

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wherein a length of each upward transmission bandwidth control frame obtained by the upward bandwidth allocation determining unit is changeable.

16. A communication control device according to claim 13, wherein a length of each upward transmission bandwidth control frame obtained by the upward bandwidth allocation determining unit is changeable.

17. A communication control device according to claim 13, wherein a transition frame is inserted into the upward transmission bandwidth control frames by the upward bandwidth allocation determining unit so as to smoothly change the upward transmission bandwidth allocated to one child station device in cases where the upward transmission bandwidth allocated to the child station device by the upward bandwidth allocation determining unit is changed.

18. A communication control device according to claim 13, wherein the traffic volume of the upward information packets output from each identified child station device is measured by the upward traffic measuring unit by measuring an upward information packet interval of each pair of upward information packets output from the identified child station device, an empty packet interval of each pair of empty packets output from the identified child station device and the number of empty packets which are output from the identified child station device and are arranged between the pair of upward information packets, and the traffic characteristic is estimated by the upward

traffic estimating unit according to the upward packet output permission instruction, information of the upward information packet intervals of the upward information packets, information of the empty packet intervals of the empty packets and information of the number of empty packets.

19. A communication control method in a communication between a communication control device and a plurality of child station devices through a single transmission medium and a multiplexing-demultiplexing unit, comprising the steps of:

producing an upward packet output permission instruction indicating the allocation of the usable slots of an upward signal for each child station device;

producing identification information from both a transmission delay time between the communication control device and one child station device and the upward packet output permission instruction of the child station device for each child station device;

sending each upward packet output permission instruction to the corresponding child station device to allow each child station device output upward packets arranged in the usable slots;

judging whether each of a plurality of upward packets sent from the child station devices in response to the upward packet output permission instructions is an upward information packet having valid information or an empty packet having invalid information;

identifying each child station device, from which a

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plurality of upward information packets and empty packets currently judged are output, according to the identification information of the child station device;

measuring a traffic volume of the upward information packets output from each identified child station device according to packet type information obtained in the judging step;

estimating a traffic characteristic of the upward information packets output from each child station device according to both the upward packet output permission instruction and the traffic volume;

determining an upward transmission bandwidth allocated to each child station device according to the traffic characteristic; and

changing the upward packet output permission instruction according to the upward transmission bandwidth for each child station device to change the identification information according to the changed upward packet output permission instruction for each child station device and to send each changed upward packet output permission instruction to the corresponding child station device.

20. A communication control method according to claim 19, further comprising the steps of

partitioning a plurality of slots of the upward signal of the upward packets output from the child station devices into a plurality of upward transmission bandwidth control frames;

controlling the outputting of the upward packets from each child station device in response to the corresponding

changed upward packet output permission instruction in each upward transmission bandwidth control frame; and

instructing the corresponding child station device according to the corresponding upward packet output permission instruction to output a plurality of upward packets at equal intervals in each upward transmission bandwidth control frame.

21. A communication control method according to claim 19, further comprising the steps of

partitioning a plurality of slots of the upward signal of the upward packets output from the child station devices into a plurality of upward transmission bandwidth control frames;

controlling the outputting of the upward packets from each child station device in response to the corresponding changed upward packet output permission instruction in each upward transmission bandwidth control frame; and

instructing the corresponding child station device according to the corresponding upward packet output permission instruction to output a plurality of upward packets at unequal intervals in each upward transmission bandwidth control frame.

22. A communication control method according to claim 19, wherein the step of measuring the traffic volume comprises the step of

measuring an upward information packet interval of each pair of upward information packets output from the identified child station device and the number of empty

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packets which are output from the identified child station device and are arranged between the pair of upward information packets, and

the step of estimating the traffic characteristic comprises the step of

estimating the traffic characteristic according to the upward packet output permission instruction, information of the upward information packet intervals of the upward information packets and information of the number of empty packets.

23. A communication control method according to claim 21, further comprising the step of:

inserting a transition frame into the upward transmission bandwidth control frames so as to smoothly change the upward transmission bandwidth allocated to one child station device in cases where the upward transmission bandwidth allocated to the child station device is changed.

24. A communication control method according to claim 21, wherein the step of measuring the traffic volume comprises the step of

measuring an upward information packet interval of each pair of upward information packets output from the identified child station device, an empty packet interval of each pair of empty packets output from the identified child station device and the number of empty packets which are output from the identified child station device and are arranged between the pair of upward information packets, and

the step of estimating the traffic characteristic comprises the step of

estimating the traffic characteristic according to the upward packet output permission instruction, information of the upward information packet intervals of the upward information packets, information of the empty packet intervals of the empty packets and information of the number of empty packets.

25. A parent station device, which is connected with a plurality of child station devices through a single transmission medium and a multiplexing-demultiplexing unit to communicate with the child station devices by sharing a whole upward transmission bandwidth of the transmission medium, comprising:

a packet type judging unit for judging whether each of a plurality of upward packets sent from the child station devices is a high priority packet, a low priority packet or an empty packet;

a packet number counting unit for counting the number of high priority packets judged by the packet type judging unit for each child station device and counting the number of low priority packets or the number of empty packets judged by the packet type judging unit for each child station device;

a surplus bandwidth sharing unit for calculating a surplus transmission bandwidth by subtracting both a sum of minimum transmission bandwidths allocated to the child station devices and a sum of high priority packet transmission bandwidths allocated to the child station

devices from the whole upward transmission bandwidth of the transmission medium, and sharing the surplus transmission bandwidth among the child station devices so as to give a partial surplus transmission bandwidth to each child station device according to the number of low priority packets or the number of empty packets counted by the packet number counting unit for the child station device;

a bandwidth adding unit for calculating an upward transmission bandwidth allocated to each child station device by adding the minimum transmission bandwidth allocated to the child station device and the high priority packet transmission bandwidth allocated to the child station device to the partial surplus transmission bandwidth of the child station device shared by the surplus bandwidth sharing unit;

a bandwidth informing packet producing unit for producing an upward transmission bandwidth informing packet having information of the upward transmission bandwidth of each child station device calculated by the bandwidth adding unit; and

a packet multiplexing unit for multiplexing the upward transmission bandwidth informing packets of the child station devices produced by the bandwidth informing packet producing unit with downward packets to send the upward transmission bandwidth informing packets multiplexed with the downward packets to the child station devices.

26. A parent station device according to claim 25, wherein each of the upward packets sent from the child station

devices is judged by the packet type judging unit to be a communication traffic informing packet having information of a communication traffic of the upward packets, a high priority packet, a low priority packet or an empty packet,

the surplus transmission bandwidth is calculated by the surplus bandwidth sharing unit by subtracting the sum of the minimum transmission bandwidths allocated to the child station devices, the sum of the high priority packet transmission bandwidths allocated to the child station devices and a sum of communication traffic informing packet transmission bandwidths allocated to the child station devices from the whole upward transmission bandwidth of the transmission medium,

the partial surplus transmission bandwidth of the surplus transmission bandwidth is given to each child station device according to the number of low priority packets or the number of empty packets counted for the child station device by the packet number counting unit, and

the upward transmission bandwidth allocated to each child station device is calculated by the bandwidth adding unit by adding the minimum transmission bandwidth allocated to the child station device, the high priority packet transmission bandwidth allocated to the child station device and the communication traffic informing packet transmission bandwidth allocated to the child station device to the partial surplus transmission bandwidth of the child station device given by the surplus bandwidth sharing unit.

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27. A child station device, which is connected with a parent station device through a single transmission medium and a multiplexing-demultiplexing unit to communicate with the parent station device by sharing a whole upward transmission bandwidth of the transmission medium with other station devices, comprising:

a bandwidth allocation extracting unit for detecting an upward transmission bandwidth informing packet directed to the child station device from downward packets sent from the parent station device and extracting an upward transmission bandwidth allocated to the child station device from the upward transmission bandwidth informing packet:

a high priority packet producing unit for producing a high priority packet;

a high priority buffer for storing the high priority packet produced by the high priority packet producing unit;

a low priority buffer for storing a low priority packet;

an empty packet producing unit for producing an empty packet in cases where neither the high priority packet nor the low priority packet is stored in the high priority buffer or the low priority buffer at an upward packet output time; and

a reading-out control unit for determining the upward packet output time of the child station device according to the upward transmission bandwidth extracted by the bandwidth allocation extracting unit, outputting the high priority packet of the high priority buffer at the upward packet output time in cases where the high priority packet is stored in the high priority buffer at the upward packet

output time, outputting the low priority packet stored in the low priority buffer at the upward packet output time in cases where the high priority packet is not stored in the high priority buffer at the upward packet output time, and sending the empty packet produced by the empty packet producing unit at the upward packet output time in cases where neither the high priority packet nor the low priority packet is stored in the high priority buffer or the low priority buffer at the upward packet output time.

28. A child station device according to claim 27, further comprising:

a communication traffic informing packet producing unit for producing a communication traffic informing packet which has information of a communication traffic of the high priority packet and the low priority packet sent from the child station device to the parent station device; and

a packet multiplexing unit for multiplexing the communication traffic informing packet with the high priority packet produced by the high priority packet producing unit so as to store the communication traffic informing packet multiplexed with the high priority packet in the high priority buffer and to send the communication traffic informing packet multiplexed with the high priority packet to the parent station device.

29. A communication system, in which a parent station device is connected with a plurality of child station devices through a single transmission medium and a multiplexing-demultiplexing unit to communicate between

the parent station device and the child station devices by sharing a whole upward transmission bandwidth of the transmission medium, wherein the parent station device comprises:

a packet type judging unit for judging whether each of a plurality of upward packets sent from the child station devices is a type of high priority packet, a type of low priority packet or a type of empty packet;

a packet number counting unit for counting the number of high priority packets judged by the packet type judging unit for each child station device and counting the number of low priority packets or the number of empty packets judged by the packet type judging unit for each child station device;

a surplus bandwidth sharing unit for calculating a surplus transmission bandwidth by subtracting both a sum of minimum transmission bandwidths allocated to the child station devices and a sum of high priority packet transmission bandwidths allocated to the child station devices from the whole upward transmission bandwidth of the transmission medium, and sharing the surplus transmission bandwidth among the child station devices so as to give a partial surplus transmission bandwidth to each child station device according to the number of low priority packets or the number of empty packets counted by the packet number counting unit for the child station device;

a bandwidth adding unit for calculating an upward transmission bandwidth allocated to each child station device by adding the minimum transmission bandwidth

allocated to the child station device and the high priority packet transmission bandwidth allocated to the child station device to the partial surplus transmission bandwidth of the child station device shared by the surplus bandwidth sharing unit;

a bandwidth informing packet producing unit for producing an upward transmission bandwidth informing packet having information of the upward transmission bandwidth of each child station device calculated by the bandwidth adding unit; and

a packet multiplexing unit for multiplexing the upward transmission bandwidth informing packets of the child station devices produced by the bandwidth informing packet producing unit with downward packets to send the upward transmission bandwidth informing packets multiplexed with the downward packets to the child station devices as a downward signal, and

each of the child station devices comprises:

a bandwidth allocation extracting unit for detecting the upward transmission bandwidth informing packet directed to the child station device from downward signal sent from the packet multiplexing unit of the parent station device and extracting the upward transmission bandwidth allocated to the child station device from the upward transmission bandwidth informing packet:

a high priority packet producing unit for producing a high priority packet;

a high priority buffer for storing the high priority packet produced by the high priority packet producing unit;

a low priority buffer for storing a low priority packet;

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an empty packet producing unit for producing an empty packet in cases where neither the high priority packet nor the low priority packet is stored in the high priority buffer or the low priority buffer at an upward packet output time; and

a reading-out control unit for determining the upward packet output time of the child station device according to the upward transmission bandwidth extracted by the bandwidth allocation extracting unit, outputting the high priority packet of the high priority buffer at the upward packet output time as an upward packet in cases where the high priority packet is stored in the high priority buffer at the upward packet output time, outputting the low priority packet stored in the low priority buffer at the upward packet output time as an upward packet in cases where the high priority packet is not stored in the high priority buffer at the upward packet output time, and sending the empty packet produced by the empty packet producing unit at the upward packet output time as an upward packet in cases where neither the high priority packet nor the low priority packet is stored in the high priority buffer or the low priority buffer at the upward packet output time.

30. A communication system according to claim 29, wherein each of the child station devices further comprises:

a communication traffic informing packet producing unit for producing a communication traffic informing packet which has information of a communication traffic of the high priority packet and the low priority packet sent from the child station device to the parent station device; and

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a packet multiplexing unit for multiplexing the communication traffic informing packet with the high priority packet produced by the high priority packet producing unit so as to store the communication traffic informing packet multiplexed with the high priority packet in the high priority buffer and to send the communication traffic informing packet multiplexed with the high priority packet to the parent station device,

each of the upward packets sent from the child station devices is judged by the packet type judging unit of the parent station device to be a type of communication traffic informing packet, a type of high priority packet, a type of low priority packet or a type of empty packet,

the surplus transmission bandwidth is calculated by the surplus bandwidth sharing unit of the parent station device by subtracting the sum of the minimum transmission bandwidths allocated to the child station devices, the sum of the high priority packet transmission bandwidths allocated to the child station devices and a sum of communication traffic informing packet transmission bandwidths allocated to the child station devices from the whole upward transmission bandwidth of the transmission medium,

the partial surplus transmission bandwidth of the surplus transmission bandwidth is given to each child station device according to the number of low priority packets or the number of empty packets counted for the child station device by the packet number counting unit of the parent station device, and

the upward transmission bandwidth allocated to each

child station device is calculated by the bandwidth adding unit of the parent station device by adding the minimum transmission bandwidth allocated to the child station device, the high priority packet transmission bandwidth allocated to the child station device and the communication traffic informing packet transmission bandwidth allocated to the child station device to the partial surplus transmission bandwidth of the child station device given by the surplus bandwidth sharing unit of the parent station device.

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